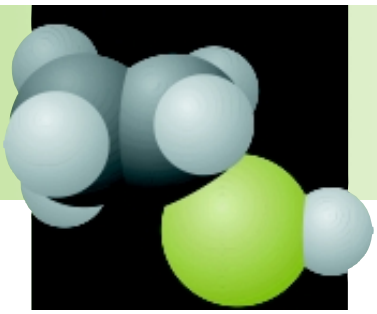
CHEMICALS

Project Fact Sheet



MEMBRANE MODULE TUBESHEET

BENEFITS

- The potential to reduce U.S. energy consumption by 200 trillion Btu per year
- Increases applicability of polymeric membranes in high temperature, chemically aggressive environments
- Improved module barrier properties
- Improved hardness without loss of toughness or flexibility
- Ability to raise the glass transistion point
- Substantially greater adhesive bond strengths

APPLICATIONS

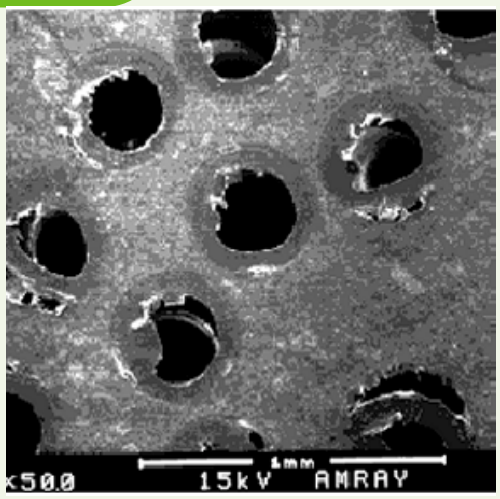
Improved tubesheets will allow hollow fiber membrane separations to replace distillation in chemical refineries. 28 percent of all the energy used in chemical plants is consumed by distillation based separations. If 10 percent of this capacity were replaced by pervaporation membranes or hybrid distillation/pervaporation systems, the annual U.S. energy saving would be significant.

NEW EPOXY TUBESHEETS INCREASE THERMAL AND CHEMICAL STABILITY OF MEMBRANE MODULES FOR INDUSTRIAL SEPARATIONS

Efforts to develop hollow fiber membranes for chemical applications have focused primarily on development of new membrane materials. Less attention has been paid to the remainder of the module components. In particular, one module component, the tubesheet, limits the extension of hollow fiber membranes modules to new and desirable applications. The epoxy materials commonly used in the tubesheets are subject to higher temperatures, operator misuse and aggressive chemical conditions that cause the tubesheet to crack and fail. Improving the epoxies used to form membrane module tubesheets can expand the application of energy efficient polymeric membrane separations.

This project will develop nanocomposite epoxy tubesheets that can operate in high temperatures (potentially to 140°C) and in chemically aggressive environments (streams containing hydrogen and hydrocarbons). In addition to improving the barrier properties of the epoxy tubesheets, nanoparticle additives offer readily dispersibility, low costs, and a wide range of surface chemistries. The improved epoxy tubesheets will allow polymeric membranes to be utilized in harsh environments not currently feasible, such as refinery applications.

Nanocomposite Tubesheet



Image, taken with an electron microscope, shows a cross-section of hollow fiber membranes potted in an organic-inorganic nanocomposite tubesheet.

Project Description

Goal: Enhance the capabilities of hollow fiber membrane separations used in industrial process streams by improving the epoxy tubesheet. The tubesheet holds the fibers in place and allows the separation modules to be constructed.

At higher temperatures or in aggressive chemical environments, the epoxy tubesheet fails (generally by cracking) thereby destroying the usefulness of the membrane module. Improving the performance of the epoxy tubesheet by incorporating surface functionalized nanoparticles into the epoxy resin should result in nanocomposite tubesheets with better barrier properties and toughening. Both improvements will lead to extended operating conditions for the hollow fiber membranes.

Progress and Milestones

Significant progress has been made in the following areas:

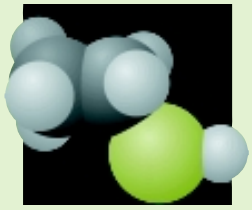
- Synthesis and characterization of a series of surface funtionalized nanoparticles
- Incorporation and complete dispersion of the nanoparticles in epoxy resins used to manufacture tubesheets
- Preparation and initial evaluation of nanocomposite tubesheet test articles
- Initial evaluation of the mechanical, thermal, and solvent resistant behavior of the nanoparticle-epoxy materials.

Future research will focus on achieving the following milestones:

- Choose the best candidate to formulate a resin with optimal properties
- Produce large (4000-5000 fibers) fiber bundles and evaluate viscosity and wetting effects on the production of the tubesheets
- Evaluate the effect of thermal cycling and chemical exposure on the durability of the tubesheets

Commercialization

TDA Research, Inc. is developing the basic nanoparticle technology and methods to disperse the nanoparticles into the epoxy tubesheets in cooperation with the Permea division of Air Products and Chemicals. TDA is signing a licensing agreement with Air Products and Chemicals, Inc. whereby Air Products will manufacture and market the nanoparticles, while both TDA and Air Products will be responsible for customer inquiries and ongoing research to meet customer needs.



Project Partners

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